

High-Energy-Density Capacitors

Multilayer technology for high performance

We are creating new designer materials using multilayer technology. These hybrid materials offer many potential advantages because structure is controlled at the near-atomic level. One noteworthy application: capacitors with exceptional performance.

Capacitors with significant advantages

By depositing alternating thin layers of metal and dielectric, we can create parallel-plate capacitors with significant advantages over existing capacitors. Extremely high-energy densities ($>5 \text{ MJ/m}^3$) are achievable with this new technology.

Multilayer capacitors are solid-state devices with excellent thermal and mechanical properties—perfect for harsh environments. The very thin dielectric is intrinsically free of defects and has a higher breakdown voltage and lower failure rate than ordinary thick dielectrics. The dielectric can be constructed of several layers of different materials to optimize its mechanical and electrical characteristics.

APPLICATIONS

- Ignition systems
- Lasers
- X-ray generation
- Physics research
- Power supplies
- Electric vehicles
- Solar-powered equipment

Conductors such as copper and aluminum can be applied in an optimum fashion. For example, a tapered sheet (rather than a flat sheet) can be fabricated to optimize current distribution and reduce weight. Connections between plates are formed as the plates are deposited, eliminating interconnection problems and guaranteeing low resistance. Low inductance is

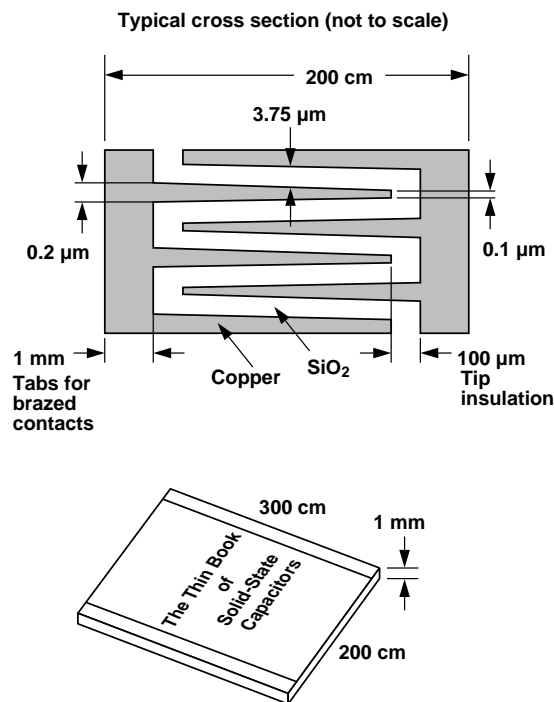
assured by a simple planar format that enhances high-frequency performance.

A high-energy example

The figure shows a multilayer capacitor the size of a thin (1-mm) Note Pad. A number of Note Pads can be connected in series and/or in parallel to produce a large capacitor bank.

Note Pad specifications:

- Number of layers 256
- Breakdown voltage 2600 V
- Energy density 6 MJ/m³



Schematic of Note Pad Capacitor and structural cross section.

- Specific energy 2 kJ/kg
- Loss (pulse application) 0.25%

These values represent an order of magnitude increase in energy density over present technology—with improved efficiency.

Because of their exceptionally low loss and low inductance, multilayer capacitors are well suited to pulse-power applications such as ignition systems, lasers, x-ray generation, and physics research. High-energy density and efficiency promote applications in power supplies, electric vehicles, and solar-powered equipment.

Availability: The technology is available now. We seek industrial partners with whom we can develop large capacitor banks for commercial applications.

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